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Outstanding X-ray emission from the stellar radio pulsar CU Virginis

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Abstract

© ESO 2018. Context. Among the intermediate-mass magnetic chemically peculiar (MCP) stars, CU Vir is one of the most intriguing objects. Its 100% circularly polarized beams of radio emission sweep the Earth as the star rotates, thereby making this strongly magnetic star the prototype of a class of nondegenerate stellar radio pulsars. While CU Vir is well studied in radio, its high-energy properties are not known. Yet, X-ray emission is expected from stellar magnetospheres and confined stellar winds. Aims. Using X-ray data we aim to test CU Vir for intrinsic X-ray emission and investigate mechanisms responsible for its generation. Methods. We present X-ray observations performed with XMM-Newton and Chandra and study obtained X-ray images, light curves, and spectra. Basic X-ray properties are derived from spectral modelling and are compared with model predictions. In this context we investigate potential thermal and nonthermal X-ray emission scenarios. Results. We detect an X-ray source at the position of CU Vir. With LX ≈ 3×1028 erg s-1 it is moderately X-ray bright, but the spectrum is extremely hard compared to other Ap stars. Spectral modelling requires multi-component models with predominant hot plasma at temperatures of about TX = 25 MK or, alternatively, a nonthermal spectral component. Both types of model provide a virtually equivalent description of the X-ray spectra. The Chandra observation was performed six years later than those by XMM-Newton, yet the source has similar X-ray flux and spectrum, suggesting a steady and persistent X-ray emission. This is further confirmed by the X-ray light curves that show only mild X-ray variability. Conclusions. CU Vir is also an exceptional star at X-ray energies. To explain its full X-ray properties, a generating mechanism beyond standard explanations, like the presence of a low-mass companion or magnetically confined wind-shocks, is required. Magnetospheric activity might be present or, as proposed for fast-rotating strongly magnetic Bp stars, the X-ray emission of CU Vir is predominantly auroral in nature.

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Keywords

Stars: activity, Stars: chemically peculiar, Stars: individual: CU Vir, Stars: magnetic field, X-rays: stars

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